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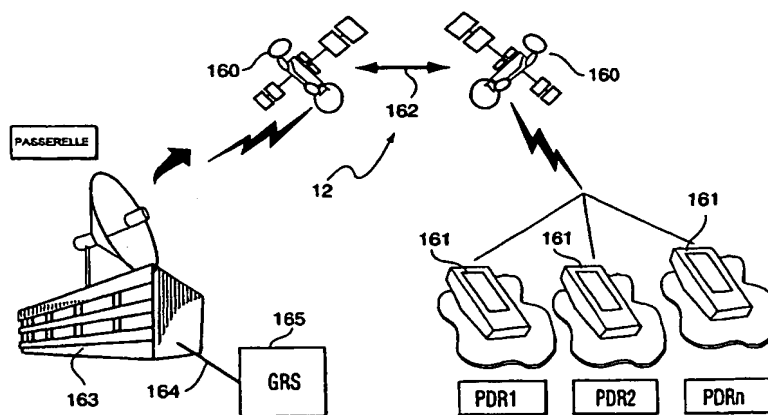
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(54) Title: SYSTEM FOR PROVIDING ENTERTAINMENT AND EDUCATIONAL SERVICES ON DEMAND TO SUBSCRIBERS



(57) Abstract: A method and system for providing individual subscribers expressive works such as vocal or instrumental music and educational or literary works that the subscribers have independently selected. The system includes a personal digital radio for each subscriber that is linked through a communications network to a single global radio station or to a number of regional radio stations depending on the communications networks used. The radio station stores a collection of expressive works in a digital data base and produces a categorized index which is stored at the radio station and at each of the personal digital radios. A subscriber uses the index to produce one or more lists each having at least one selected expressive work. When determined by the subscriber, the works on a selection list will be sequentially obtained from the radio station and played substantially immediately on receipt by the subscriber's personal radio. The obtain a work from the radio station, each individual request is formulated and transmitted to the radio station, the radio station accesses the work and transmits the work in digitized form to the subscriber's personal radio.

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SYSTEM FOR PROVIDING ENTERTAINMENT AND EDUCATIONAL SERVICES ON DEMAND TO SUBSCRIBERS

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Field of the Invention

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This invention relates generally to on-demand electronic entertainment/educational services and in particular to providing expressive works to a subscriber under the subscriber's direct control.

Background of the Invention

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Electronics and telecommunications advances have provided enumerable facilities for delivering audio and video entertainment and educational services to the public. Facilities such as tape, CD or video players are totally under the control of an individual, while other facilities such as public broadcasting or on-demand in-home reception that an individual receives from some central location, are only partially under the individual's control, if at all.

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In the electronic entertainment and educational fields and particularly the music industry, there are four areas of concern, namely, the speed at which data storage media for expressive works becomes obsolete, the difficulty for the public to hear new entertainers, the inherent Copyright violation opportunities generated by electronic products, and the need to choose between portability with either little or no choice on program selection or broad choice of selections without portability.

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The continuous evolution of the medium on which data is being stored, ie from Vinyl LP's to 8-Track tapes to Cassette Tapes to Compact Discs, Digital audio tapes, audio DVD's, and MP3 memory sticks, is punitive to the consumer who is continually forced to make expensive upgrades to both the new storage media and the new hardware

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required to use the new media. The consumer has no choice but to repeatedly re-purchase the collection of expressive works each time the media is upgraded. The ideal situation for the consumer would be to have a standard format used by the consumer which is unlikely to change well into the future.

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Optimally the consumer would prefer to have access to any expressive work such as music that has been created by any artist. However, the evolution of the music distribution industry makes it difficult for the entry of new, unknown and unproved entertainers. The risk involved in the production of entire albums by musicians in certain genres of music result in the limitation of exposure for these entertainers. Therefore the public is limited in their selection of music.

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Copyright law pertaining to music whether audio or video, but particularly audio is subject to violation with the introduction of tape and CD writers. And now with the MP3 music format available on the Internet, consumers are able to infringe on copyright laws by downloading songs to their MP3 Player's memory sticks, hard drives, CD writers and other digital storage devices. The ability to copy music in this manner jeopardizes the musician's ability to earn a living, and ultimately reduces the supply of new music to the consumer. Ideally musicians or the owners of the works should be paid for their work in direct proportion to the popularity of their music, in the form of a royalty every instance their songs are being heard.

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AM & FM radio stations play pre-selected songs at random or according to their own programming decisions. The consumer has no, or very little control over the content or the time at which the content is aired. In order for the consumer to be able to freely select the materials desired, pre-recorded music is listened to either with a fixed home stereo system or with a portable apparatus. In order to have a large choice of custom music at hand, an individual is forced to use a home stereo system thereby sacrificing portability. The consumer must therefore choose between the freedom of portability or the immediate access to a large selection of music. Audio consumers would benefit

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greatly from the ability to choose what they want to hear from an infinite variety of music and other audio content and when they want to hear it according to their own schedule.

The public broadcast of lectures, language training and other literary works are also severely limited both in availability and accessibility. Currently, broadcasts of this kind are aired occasionally and at set times on a limited number of stations. Ideally an individual would prefer to request an educational lecture, audio play, talking book or any other educational or entertainment track at a time and location convenient to him or her.

Various attempts have been made to provide expressive works to individuals more or less on demand. Some of these efforts utilize the Internet and are based on downloading or copying digital music files onto the user's computer storage device or on an MP3 Player's memory sticks. The other currently popular method is through an Internet player such as "Real Player" by Real Networks. This provides streaming audio which requires a delayed signal to buffer the digital file as the constraints of the bandwidth prevent it from real-time on-demand delivery.

Further systems are described in USP 5, 541,638 which issued on July 30, 1996 to Story and USP 5,819,160 which issued on October 6, 1998 to Foladare et al. These systems provide a subscriber with a series of preselected expressive works from a play list stored in a central subscription control centre. The play list is formulated in the control centre through interactions with the subscriber.

Summary of the Invention

It is therefore an object of the present invention to provide a method and apparatus for providing individual subscribers with expressive works independently selected by the subscribers.

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The system in accordance with the present invention comprises a subscriber device for each of the subscribers to select an expressive work from an index of a collection of expressive works, the index being located in each of the subscriber devices. The subscriber device further makes a request for the selected expressive work. A central station accesses the collection of expressive works and transmits to the subscriber device the expressive work requested by the subscriber for substantially immediate performance. The subscriber device may include a transmitter/receiver module for transmitting the request to the central station, a control module for maintaining the index and for interfacing with the subscriber to select expressive works and a player circuit for receiving and performing the requested expressive work. The central station may include a plurality of servers for hosting the collection of expressive works as a digital data bank and a supervisory server for receiving requests from the subscriber devices and allocating the requests to the servers.

In accordance with another aspect of the invention the plurality of servers may be coupled to the supervisory server through a broadband transmission medium, and the subscriber devices are coupled to the central station means through a communications network that could include a constellation of low earth orbit satellites.

In accordance with another aspect of the invention, one or more regional stations each having access to the collection of expressive works, transmit to each subscriber associated with the regional station the expressive work requested by the subscriber for substantially immediate performance. The supervisory servers from the regional stations may be linked together through a broadband transmission medium to maintain identical collections of expressive works.

In accordance with further aspect of this invention, the communications network linking regional stations with subscriber devices may include one or more of the followings systems: a cellular network, an rf network, an xDSL network, a standard cable system and/or a direct broadcast satellite system. In addition, the communications network may include a first low transmission rate network for transmitting subscriber

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device requests to a regional station and a second high transmission rate network for transmitting the expressive work from the regional station to the subscriber device.

In further specific aspects of this invention, the supervisory server may include a facility for appending further expressive works to the digital data base and for generating index updates for the appended further expressive works, the index updates being transmitted to the subscriber devices for storage.

In one preferred embodiment, the expressive works are audio works comprising but not limited to vocal and instrumental music, educational and literary works.

The method for providing individual subscribers with independently selected expressive works in accordance with the present invention comprises selecting an expressive work from a local index of a collection of expressive works, formulating a request for the selected expressive work, transmitting the request to a central location having access to the collection of expressive works, and transmitting the selected expressive work to the requesting subscriber for substantially immediate performance. The method may further include periodically adding further expressive works to the collection of expressive works, creating an index update of the expressive works added to the collection of expressive works and transmitting the index update to each of the subscriber locations.

In accordance with a further aspect of this invention, the subscriber may develop a favorites list including one or more selected works, whereby the selected works may be requested one at a time as they are being played in a predetermined sequence.

In accordance with another aspect of this invention, the method for providing individual subscribers with independently selected expressive works comprises storing a collection of expressive works in a central location, creating an index of the collection of expressive works, storing the index at the central location and at each local subscriber locations. At the subscriber locations, selecting one or more expressive works from the

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local index at any time as determined by the individual subscribers, formulating requests for an individually selected work at the individual subscriber locations, transmitting the requests from the individual subscriber locations to the central location. At the central location, accessing the selected expressive works requested by the individual subscriber locations, transmitting the respective requested expressive works to the respective individual requesting subscriber locations. And at the subscriber location, performing the transmitted works.

With respect to specific aspects of this invention, the index is a categorized index.

In addition, the expressive work transmitted is buffered in the subscriber location such that the subscriber may select a point in the buffered expressive work to determine the point of play of the expressive work.

Many other objects and aspects of the present invention will be clear from the detailed description of the drawings.

Brief Description of the Drawings

Embodiments of the invention are described with reference to the drawings in which:

Figure 1 schematically illustrates the Personal Digital Radio (PDR) system in accordance with the present invention;

Figure 2 schematically illustrates a Global Radio Station (GRS) in accordance with the present invention;

Figure 3 illustrates the status packet produced for each server in a GRS;

Figure 4 illustrates the process for adding works to the Digital Audio Data Bank;

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Figure 5 details the database files and software programs used to manage the system;

Figure 6 illustrates the process steps in a GRS when a request is received from a PDR;

Figures 7a and 7b illustrate one design of a PDR in accordance with the present invention;

Figure 8 illustrates another design of a PDR in accordance with the present invention;

Figure 9 illustrates the electronic components of a PDR;

Figure 10 illustrates data flow within the PDR;

Figure 11 is an example of category selection buttons that may be generated to appear on the PDR display;

Figure 12 is an example of possible play control buttons on a PDR;

Figure 13 illustrates the selection subroutine for the PDR;

Figure 14 illustrates the form that a PDR request packet may take;

Figure 15 illustrates the form that a GRS data packet may take;

Figure 16 schematically illustrates a PDR system with a constellation of low earth orbit satellites as a communications network; and

Figure 17 schematically illustrates a PDR system having a variety of communications methods.

Detailed Description of the Drawings

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Though the present invention will be described with regard to audio expressive works and that the terms used to describe the components are primarily used with regard to audio, it is within the scope of the present invention that it be applied to systems for all forms of expressive works.

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The system 10 in accordance with the present invention referred to as NETWAVE system is illustrated schematically in figure 1 wherein each subscriber has a portable digital receiver or Personal Digital Radio (PDR) 11 which is coupled to a global transmitter station or Global Radio Station (GRS) 13 through a communications network 12. The function of the GRS 13 is to maintain or have access to a collection of expressive works, to maintain a subscriber database, to periodically transmit an index update of the expressive works to PDR's 11 in the system and to transmit selected expressive works to individual PDR's 11 when requested by those PDR's 11. The function of the subscriber's PDR 11 is to store an index of available expressive works as well as updates to the index in its memory, to facilitate the selection of one or more expressive works through the subscriber's interaction with the PDR 11 using the index in memory, to transmit a request for a selected expressive work to the global transmitter station 13 and to receive and play the requested expressive work for the subscriber.

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In one embodiment of the present invention, the collection of expressive works may include, in an Digital Audio Data Bank, musical and vocal works of every type and from an unlimited number of artists whether they have a large number or only one piece available. In addition, the Digital Audio Data Bank may include such things as university or other lectures for students and others, language training programs, talking books, famous speeches, various literary works such as audio plays, comedy sessions,

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religious and inspirational programs, and or sporting events. In addition, the NETWAVE system may find applications for voice mail, in jukeboxes and by disk jockeys.

Voice mail can be temporarily stored by reference to the subscriber's ID in the library as a digitized audio file to be retrieved on demand as any audio file by the subscriber. A jukebox can be manufactured using the PDR as the heart of the system with the addition of an amplifier, speakers and a vending mechanism. Disk jockeys can utilize a PDR unit to perform at dances, weddings and other public functions instead of using CD's or tapes.

The hardware for the Global Radio Station 13 as illustrated in figure 2 comprises a plurality of computer servers 21 which are linked together by fiber optic links 22 through a supervisory server 23. The servers 21 host the Digital Audio Data Bank of expressive works. The Digital Audio Data Bank may be replicated in the individual servers 21 which may each have a cluster of servers around them, or it may be distributed over the servers 21. The servers 21 utilize an optimized network architecture in which a plurality of servers 21 are distributed in a geographically symmetrical server network. Under certain communications network configurations, the GRS 13 may be trunked through a high-speed fiber-optic data transmission backbone 24 to regional gateways that will be described later with regard to figure 17.

Based on status packets 29 of the type illustrated in figure 3 that are received from each of the servers 21 (1....n) by the supervisory server 23, the supervisory server 23 utilizes a data flow routing algorithm to have the servers 21 take over requests for data according to the proximity of the subscriber 11 and the load demand on the servers 21. This algorithm acts as a load balancer to optimize network traffic based on the location, timing of subscriber requests, and demand on each server 21. This increases the speed at which the data is delivered to the subscriber 11 and reduces network congestion.

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When a subscriber's request for an audio file is received at the GRS 13, the supervisory server 23 distributes these requests in the most efficient method according to the routing algorithm described in figure 3. This routing algorithm is based on load proximity values that are derived from Status Packets 29 received on request from the servers 21 (1.....n). This provides the supervisory server 23 with a means to determine which server 21 can most efficiently fulfill the subscriber's request.

The servers 21 at the GRS 13 are polled - step 31 for a status packet after the subscriber's request - step 30 is received. The variable S is the status of the server, P is the proximity of the server, Y is the server #, X is the combined status and proximity variable and T is the server 21 with the highest status value. The packet 29 contains the network address of the server 21 and a status byte which is a percent value snapshot of the performance level of the server 21. A calculation is made to determine the proximity of the server 21 - step 32 to the subscriber based on their network address and the value is stored in the value P - step 33. Another calculation is made to derive a combined percent value of performance and proximity server - step 34. This status value is then compared to the last highest server's status value - step 35. If it is higher, then it is posted in the variable T - step 36 and its percentage value is stored in variable X for further comparison with other servers. The server number is incremented - step 37 and the next server's status value is compared to the current highest value X until all of the servers 23 are checked and the highest performing server 23 relative to the current subscriber's request is defined - step 38. The subscriber's request packet is then forwarded by the supervisory server 21 to the most efficient server 23 to provide the audio file requested - step 39.

The Digital Audio Data Bank at the GRS 13, is continually appended by contributions of expressive works including audio materials such as music, educational, and other expressive works. These are received in a standard compressed digital format such as MPEG-1, LAYER-3 (MP3) developed by the Moving Picture Coding Experts Group (MPEG). Other audio formats such as audiotapes, records and CD's can be converted at the GRS 13 to the standard MPEG or other digital format.

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The process for adding expressive works to the Digital Audio Data Bank is illustrated in figure 4. When a new audio file is received - step 40, the content is converted to digital format - step 41 if needed and then compressed - step 42. The content provider's index or account is checked - step 43 in the content provider database 430 to determine whether or not an account currently exists for that content provider. If an account does not exist, then a new account is created in the content provider database 430. The audio file is then checked for integrity - step 44, if the file does not pass the integrity test, the file is rejected and a resubmission request is made - step 440. The accepted audio file is assigned a unique audio file serial number - step 45 that preferably includes 4 bytes and the audio file is classified by category - step 46 such as educational-science-technology, or music-rock and roll-1970's. A date stamp is placed in the "date-release" field - step 47. The date-release field is used for creating a new release category for immediate subscriber access to new releases. The file is then appended - step 48 to the Digital Audio Data Bank 480 with the serial number as the header. The fields serial number 490, song/title 491, artist/provider 492, volume/CD 493, category/genre 494, mood/topic 495, number of requests 496, release date 497 and length (in seconds) 498 are compiled into a new record 49 and saved in the index database 50 with the file's serial number as the header.

The digital files of expressive works may be stored on an array of hard disk drives and virtual memory drives in the servers 21 (figure 2). Each digital file has a unique serial number based on a 4 byte code. This 4 byte code will allow a capacity of 4,294,967,296 individual audio files when a 32 bit code is used. This serial number is used as an index for retrieval, accounting, and cataloguing.

Each transmission of an audio file to a subscriber increases a cumulative counter 496 in favor of the author, which determines the amount of royalties periodically paid to the author. This cumulative counter 496 is also used to determine the popularity of a music/educational file. The statistics generated by the counter 496 will be broadcast to the subscriber in an index containing the form of top requested songs, books or lectures. All further submissions by artists and educational providers are appended to the Digital

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Audio Data Bank 480 on a regular basis, such as daily, and the categorized index 50 of the Digital Audio Data Bank 480 is updated. The entire categorized index 50 is contained on the EEPROM 911 (figure 9) of a new subscriber's PDR 11, however current subscribers 11 (figure 1) will receive the updated portion of the index 50 reflecting the current content of the Digital Audio Data Bank 480. Frequently, a general broadcast of the index update is launched from the GRS 13 to all PDR's 11 (figure 1) during a low transmission period, such as at 4:00 a.m. local time. This allows subscribers 11 to create their selections based upon the current index 50 of all audio files available from the Digital Audio Data Bank 480. This also allows content providers to showcase their compositions through the "new release" category to the global audience soon after they have been created and categorized.

The GRS 13 manages the Digital Audio Data Bank 480, regional content providers and regional subscribers 11 through corresponding data base files and software programs located in the servers 21 and the supervisory server 23. Figure 5 illustrates a database structure that may be employed.

The Audio Data Bank Database File 48 contains the inventory of audio files such as music and other audio expressive works. Each record in the file is composed of a compressed audio file preceded by a 32-bit serial number identifying it. This file is appended when a further submission is submitted from a content provider. This is the master database for the audio files and subscribers directly access this database for files of expressive works.

The Index Database File 49 contains category descriptors of the audio files residing in the Audio Data Bank referenced by the corresponding 32-bit serial number mentioned above. The index database resides at each server 21, 23 of the GRS 13 and a copy also resides in at each PDR 11 unit. The subscribers search, sort, and retrieve a requested file using a search engine on the PDR 11, which references the index database file 49.

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As illustrated in figures 4 and 5, the following categories may be included in the data base: Audio File Serial No. 490 is the audio file tag # used to identify audio files throughout the NETWAVE system; Song/title 491 contains the audio file's title such as the song's name; Artist/author 492 contains the expressive work author or creator's name; CD/Volume 493 contains the name of the collection of works that this file is part of, for example, the name of an album or CD; Genre/category 494 describes the type of music or audio track grouping such as rock/jazz, science/astronomy, comedy/literature; Mood/topic 495 provides another way to identify, sort, and group the audio files in the Digital Audio Data Bank such as dance music/romantic music, mystery books/science fiction books, french language learning; Number of Requests 496 is a cumulative counter that is incremented with each audio file request, it is used to provide statistical information for subscribers such as displaying the top ten requested songs with this genre and to determine payment for content providers for use of their work; Release Date 497 has a date stamp indicating the date the audio file was released to the public and is used to provide lists for subscribers as in new releases, seventies music, and other such groupings; and Length in Seconds 498 contains the length of the audio file in seconds and is used for accounting and to calculate the subscriber's total playtime.

The index database 49 is appended each time an audio file is added to the Digital Audio Data Bank 48 as it contains all the descriptors for the audio files contained in the Digital Audio Data Bank.

The Audio Data Log Database 51 records are generated with each incidence that an audio data file is accessed by a subscriber. This log file is used for tracking usage and in accounting. The Audio Data Log Database 51 is an ongoing history file that is periodically archived. Its content headings are: the Date & Time 510 stamp that indicates when the file was accessed; the Audio File Serial No. 511 that is used to identify audio files throughout the NETWAVE system; and the Subscriber's PDR Code 522 that identifies the PDR 11 unit used to access the file.

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The Subscriber's Database 52 is a database of all subscribers on the NETWAVE system. It contains the serial number of the PDR 11 unit each subscriber is using and general address information. This is the master database for subscribers.

5 The Content Providers Database 53 is a database of all content providers on the NETWAVE system. It contains each artist/author name and general address information. This is the master database for content providers.

10 The Subscriber's Transaction Database 54 is a history of the subscriber's requests. This file is used by the accounting program to generate billing information for each subscriber. It includes: the Subscriber's PDR Code 540 that identifies the PDR 11 unit used to access the file; the Beginning Balance 541 that indicates the audio playtime available in the subscriber's account; the Date & Time 542 stamp indicates when the file is accessed; the Song/title 543 that identifies that the last audio file accessed by
15 subscriber; the Length in Seconds 544 that is the length of the audio file requested in seconds and is used for billing time; and the new Beginning Balance 545 that indicates the value of audio playtime remaining in the subscriber's account after the present work is played. The Current Balance 545 = Beginning Balance - last requested file length in seconds and is generated each time a subscriber listens to an audio file. It pools its
20 information from the PDR's requests and the fixed values in the database files described above.

25 The Content Providers Transaction Database 55 keeps a usage tally of audio files, to provide an accurate accounting for content providers. Using this database, accounting can generate credits for each content provider. The database includes: the Account Code 550 that is an assigned code for each content provider; the Date & Time 551 stamp that indicates when the file is accessed; the Song/title 552 that is the name of the audio file last accessed by a subscriber; the Account Balance 553 that is the current account balance indicating a cumulative value of the number of times this song/title has been accessed to
30 date by a subscriber; the Time Accessed 544 that is the total value of time (HH:MM:SS) subscribers have accessed this content provider (based on all their expressive works); and

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% Popularity by City 545 that is a percentage indicating a statistical value showing how popular the content provider is by cities. This can be used by the artist/author of expressive works to prepare targeted marketing initiatives such as advertising and concert/lecture tours.

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Figure 6 illustrates the process steps taken in GRS 13 when a request for an audio file is received from the subscriber's PDR 11 (figure 2). The process starts - step 60 when a request is received as a PDR packet 140 (figure 14) through the communications network 13. After the integrity of the packet is checked - step 61, the length of the audio file 498 is checked against the time available 541 in the subscriber's data base - step 62. If the subscriber does not have sufficient time to play the entire file, then an ALERT byte is sent back to the subscriber's PDR 11 to launch an on-line subscription renewal software program - step 63 by which the subscriber may purchase time credits for his account. This may be done automatically if the subscriber purchases time through preauthorized credit card transactions for instance. If sufficient time is available, then the subscriber's Beginning Balance 541 is reduced by the length 498 of the audio file - step 64, and the audio file's counter field 496 in the index data base 49 is incremented by one to reflect usage - step 65. The subscriber's usage log 51 is appended with the time 510 of the request and the serial number 511 of the audio file - step 66. The requested audio file is broken down into 16 or 64 kilobit packets 150 (figure 15), each addressed with a header and a checksum field and transmitted through the communications network 12, using network protocol, to the subscriber - step 67. The GRS 13 routine is then ended - step 68.

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The data packets 150 illustrated in figure 15 may be composed of the following:

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- 8-byte Preamble code alerts the beginning of a packet;
- 4 byte address of the Digital Radio Station's 13 server 23;
- 4 byte address of the PDR 11 that requested the file;
- 2 byte code for type of data to follow (audio file packet # for assembly use);

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- 16K or 64K of audio file data; and
- 4 bytes of checksum data for an integrity check.

The design of the Personal Digital Radio 11 may take many forms such as the models illustrated in figures 7a, 7b and figure 8. In figures 7a and 7b, only the face of the PDR 70 casing is illustrated in the closed position figure 7a and in the open position figure 7b. The closed face of PDR 70 includes a window 71 through which a portion of the PDR display 72 is visible. PDR 70 further includes a set of control buttons 73 and a set of multiple selection play buttons 74. Control buttons 73 may follow closely the controls used on standard video or audio players as illustrated in figure 12. For instance control buttons 73 may include a play button 733, a stop button 732, a pause button 734, a fast forward button 735 and a rewind button 731. Multiple selection play buttons 74 deal with the playing of a list of desired selections. For instance they may include a continuous play button 741 whereby works from a selected list will be repeatedly replayed, a favorites button 742 whereby works from a list of favorites will be played, and a shuffle button 743 whereby works from a selected list will be replayed in random order. PDR 70 further includes a scroll wheel 75 which can be used to scroll and select anything appearing in the window 71 when the PDR 70 is closed or on the display 72 when the PDR 70 is open by rotating the scroll wheel 75 and pressing it in.. PDR 70 may further include a speaker (not shown) or a jack 76 which may be connected to headphones or an audio system in the car or at home. In the open position shown in figure 7(b), PDR 70 is shown to include two further sets of buttons 77 and 78 which are used by the subscriber to make selections of the works that he wishes to receive. The six buttons 77 shown at the top of the display 72 may be fixed mechanical buttons above the display 72 or touch sensitive buttons on the display 72. Buttons 77 represent categories of works from which selections will be made. For instance button 771 may represent song/title, 772 - artist/author, 773 - CD/volume, 774 - genre/category, 775 - new releases and 776 - top ten works. An example of an alternate expanded set of category buttons is illustrated on figure 11. Button set 78 represents selection control, where button 781 calls up a list of works found in the category or categories selected by buttons

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77, button 782 adds the work highlighted by scroll wheel 75 onto a list of favorite selected works and button 783 deletes the work from the list of favorite selected works.

5 The PDR 80 in figure 8 is a unit designed to primarily play works from a list of favorite selected works that was created by a unit such as a fixed unit in the home to which PDR 80 is coupled by RF for instance. PDR 80 includes a casing 80, a display to show a list of favorite selected works as well as the play control buttons 82 which again can include a play button 821, a stop button 822, a pause button 823, a fast forward button 824 and a rewind button 825. PDR 80 further includes an antenna for
10 communicating with the fixed unit, and a speaker for playing the received selections.

The electronic components of the PDR 11 of the type described with regard to figures 7(a) and 7(b) is illustrated schematically in figure 9 and comprises three modules, the transmitter/receiver module 90 to control transmissions to and from the PDR 11, the
15 firmware/control module 91 for storing the index, for creating lists of favorite expressive works and for formulating requests for selected expressive works, and the player circuit 92 for playing the requested work.

The requirements for the transmitter/receiver 90 of PDR 11 will become clear in
20 the description of the various communications networks 12 which will be discussed with reference to figures 16 and 17. The preferred embodiment of the transmitter/receiver 90 is one in which the PDR 11 is capable of transmitting uplinks and receiving downlinks over the Ka band. For example, the guidelines established for the Teledesic low earth orbit satellite constellation provides for uplinks at 28.6 - 29.1 GHz and downlinks at 18.8
25 - 19.3 GHz. In another embodiment, the transmitter/receiver 90 in the PDR 11 communicates with a home based unit at an RF frequency of 2.4 GHz to provide mobility around the home, with a range of approximately 500 feet. Other embodiments of the transmitter/receiver 90 may utilize other communication channels as well as those introduced by technological advancements. As transmission methods change, this
30 module can be replaced with another module that interfaces with the technological advancement or frequency change.

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The preferred embodiment of the Firmware/Control Module 91 enables the user to display, select, and play audio files in an intuitive fashion. Firmware/Control Module 91 includes a processor 910 that is controlled by the system software stored in an EEPROM 911 which also stores the initial Audio Data Bank Index 50. A further
5 memory 912 contains file buffering, user profile information, lists of the user's favorite selections and index updates. This firmware uses an ISAM file structure for the Audio Data Bank Index 50. The processor 910 is further coupled to supporting control chipsets 913 for the display driver 914 and the keypad/button decoder 915.

10 Player circuit 92 includes a digital decompression circuit for decompressing the digital signal received from GRS 13, a digital to analog converter 921 for converting the near CD quality digital signal received (128KPS) to an analog audio signal and a line-level amplifier 922 for the audio output such as jack 76 in figure 7(a) or a speaker 84 in figure 8. A 3.5mm output jack 76 can provide a standard low impedance stereo analog
15 signal. Three different audio units may be connected to the output jack, namely 3.5mm headphones for mobile listening for walking, cycling, relaxing on beach, a 3.5mm male plug to cassette adapter for interfacing with the car tape deck or 3.5mm to RCA adapter cable for listening through a home stereo amplifier. A digital output capability would normally not be provided in order to prevent copyright infringement by copying the
20 expressive works.

In a preferred embodiment of this invention, a subscriber using the PDR 11 can select and compile a list of expressive works such as music or literary works. Several favorite selections can be grouped, and the indices stored in the PDR unit's memory 912
25 as Favorites lists. A Favorites list is a group of indices referencing a repertoire that a subscriber may want to listen to. The lists may be stored for later retrieval at which time they may be edited or used to request for the specific selections from the lists.

Figure 10 illustrates PDR 11 data flow. When the PDR 11 is switched on - step
30 100, status information such as battery level, subscription time remaining, number of audio files played, the feature of the week, may be displayed - step 101 on the display 72

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through window 71 on figure 7(a) and a password is requested step - 102. The password may be entered by using a combination of buttons in button sets 73 and 74. Verification is carried out to determine that the password is provided - step 103 and that the password is correct - step 104. Once a correct password is entered, the last requested work played previously is displayed - step 105. The button sets are scanned step -106 repeatedly - step 107 until a user input is detected step - 108.

The subscriber may want to make selections of works that he wishes to play - step 109 and calls the selection subroutine - step 110. The selection subroutine 110 procedure identified in figure 10 is shown in detail in figure 13 starts at step 130. One or more categories are chosen using button set 77 in figure 7(b) or button set 119 in figure 11. After a category or categories are selected, an alphabetical list of works culled from the Database Index 49 reflecting the category or combination of categories chosen is displayed on display 72. Scroll wheel 75 is used to pan and select audio files which with selection control button set 78 can be made into a Favorites list of one or more selections. The subroutine specifically comprises scanning a buffer for a selection - step 131. If the buffer is empty, step 131 is repeated; if a selection has been made and the buffer contains data - step 132, a decision is made - step 133 whether a further selection to be made and added to the Favorites list - step 134 or whether the selections are to be copied to the Favorites list memory file - step 135 and then the subroutine returns to step 106 in the PDR data flow chart figure 10.

To play selections, button sets 73 and 74 are used to control play. The subscriber decides whether to use the continuous play cycle - step 111, the shuffle play cycle - step 113 or neither. If either of the previous play cycles are chosen by depressing buttons 741 or 743, the appropriate subroutine - step 112 or - step 114 will be called up. To play an existent favorites list - step 115, the Favorites subroutine is initiated. Finally, play may be initiated - step 117 with its corresponding player subroutine 118 which include button set 73 functions.

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In the player subroutine 118, a request is formulated in the form of a single network packet 140 (figure 14) representing the first selection to be requested. Further requests for the other selections on the list are generated automatically but subsequently one at a time when the immediately previous request is being played by the subscriber PDR 70. Thus the creation and transmission of a subsequent PDR 11 request packet 140 to GRS 13 is timed so that the GRS 13 will respond by transmitting the GRS digital data packets 150 representing the requested work to the PDR 11 just in time for the requested works to play one after the other without dead air time between the playing of the requested works. Thus neither the list of selections, nor the series of independent requests are stored in the GRS 13.

The play button 733 (figure 7(a)) or 821 (figure 8) on PDR 11 launches over network 12 to GRS 13 a transmission of a single network packet 140 representing a single selection. In one embodiment, packet may be composed of the following as illustrated in figure 14:

- 8-byte Preamble code alerts the beginning of a packet;
- 4 byte address of the PDR 11 which is embedded in the hardware;
- 4 byte address of the Digital Radio Station's server 23;
- 2 byte code for type of data to follow (request packet or audio file);
- 4-byte code for the audio file contained in the Index Database 49; and
- 4 bytes of checksum data for an integrity check.

The PDR 11 request packet 140 is routed via the broadband network 12 to the Digital Audio Data Bank 480 where, at the file server 21, it is processed as described with respect to figure 6.

The data packet 150 is routed back to the PDR 11 via the broadband network 12 using the destination address within it. Packets 150 are queued in the memory buffer 912 of the PDR 11 until it is full. Buffer 912 could for example hold 200 - 16K packets 150

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which represents about 200 seconds of playing time. Since the data packets 150 are being buffered in the PDR's 11 memory 912, fast forward, rewind and pause features become possible. As each packet 150 represents a discrete audio playback time interval, addressing the previous or next packet 150 using the fast forward or rewind features moves the audio play pointer forward or backward by one or a number of discrete time intervals based on the length of time the feature is activated. These features are controlled by buttons 735, 731 and 734 respectively. The PDR Packets are assembled and decompressed back to an analog format through the MPEG player circuit 92.

Figure 11 illustrates a series of category buttons 119 which may appear on a PDR to be used singly or in combination in the selection process for expressive works. Figure 12 illustrates an expanded set of play control buttons 120 which in addition to the standard play 121, pause 122, stop 123, fast forward 124 and rewind 125 buttons, has a previous selection button 126 and a next selection button 127. These latter two buttons would control the PDR 11 to create and transmit a PDR packet to the GRS 13 requesting the desired selection.

The preferred wireless communication network 12 in accordance with the present invention is implemented via a constellation of low earth orbit satellites such as those proposed to be provided by the Teledesic network, but alternatively may be implemented by any wireless or wired broadband communication medium providing not less than a one megabit data transmission rate. For example, fiber optic lines, xDSL, cable network, DBS network, cellular and RF. Other communication methods may be based on a combination of the above methods or even through the Internet.

The preferred embodiment as illustrated in figure 16 is one in which a low-earth-orbit satellite 160 constellation is employed, such as the proposed Teledesic Satellite network which will permit global coverage, providing broadband wireless transmission of 64 megabits, similar to that available on fiber optic lines. Such a system can provide complete global mobility for all PDR owners. Any single PDR 161 transmits a request packet 140 signal in the Ka frequency band (28.6-29.1 GHz) to the nearest low earth orbit

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satellite 160. The request packet 140 is forwarded through the most efficient path 162 through the satellite constellation, down to the terrestrial gateway downlink 163 through a fiber optic link 164 to the GRS 165. Data packets 150 are sent from the GRS 165 back through the gateway satellite uplink 163 in the Ka frequency band (18.8-19.3GHz) and then forwarded through the most efficient path 162 in the satellite constellation to the requesting PDR 161. A carrier algorithm provides the most efficient path from the PDR 161 through the satellite 160 constellation to the terrestrial gateway 163.

In an alternate embodiment, a communication convergence strategy is employed whereby one or more communication methods as described with respect to figure 17 can be utilized to efficiently route the transmission signals between PDR's and GRS's based on geographical, technical, or other constraints. Figure 17 represents a nonexhaustive example of configurations using four different carriers. A cellular or rf system 171 is shown coupling PDR's 170 to a GRS 172, a further PDR 173 is coupled through an xDSL line system 174 to a GRS 172. Another PDR 175 is coupled to a GRS 176 through a cable system 177, and a further PDR 178 is coupled to GRS 176 through a DBS system 179. This serves two purposes, firstly, it allows users who do not have access to one of the various carriers to use the invention. For example, many consumers do not presently have access to xDSL lines but may have a co-axial cable connection. Secondly, it permits the distribution of data over more carriers, thus reducing the bandwidth required from each carrier. In addition, in this type of arrangement, it is necessary to have a number of regional GRS's 172, 176 since it is not possible to have all PDR's communicate directly with one GRS. However, all GRS's 172, 176 could be coupled together using a fiber optic backbone 191 such that the content of the GRS's 172, 176 may be coordinated. In this situation, a replication process is applied to maintain a duplicate Audio Data Bank 480 at each GRS 172, 176. When a new expressive work is added to one GRS 172 or 176, then the supervisory server at that GRS 172 or 176 would initiate the replication process to all other GRS's 176 or 172 and then to all servers in the GRS.

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When a standard RF or cellular communication system 171 is employed, a request packet 140 from a PDR 170 is sent to a reception dish/antenna 180 positioned at the top of a communications tower 181 and is routed through a fiber optic link 182 to the regional GRS 172. The data packets 150 are then sent from the regional GRS 172 through the fiber optic link 183 to the communications tower 182 that is closest to the PDR 170 that initiated the request. The data packets 150 are broadcast on RF or microwave to the PDR 170.

Similarly, the request packet 140 from the PDR 170 may be sent through the cellular network 171 and then routed through the fiber optic link 183 to the regional GRS 172. The data packets 150 are then sent from the regional GRS 172 through a fiber optic link 183 to the communications tower 182 which is closest to the PDR 170 that initiated the request. However in this case, the data packets 150 are sent to the PDR 170 by RF broadcast. This method utilizes the advantages of the mobile cellular communication for the small packets emanating from the mobile PDR 170 and the advantages of the fast and broad coverage of a RF transmission for the large data transmissions from the GRS 172.

Using a standard xDSL line system 174, a request packet 140 from a PDR 173 is sent on a wireless transmission signal to a set-top device in a fixed location 184. The transmission signal between the PDR 173 and the set-top device fixed location 184 could be either an RF signal in the 2.4 GHz band, giving it a range of 500 feet, or an infra-red transmission with a "line of sight" range. The request packet 140 is then routed through the xDSL line 185 to the GRS 172. The data packets 150 are sent from the GRS 172 through the xDSL line 185 to the fixed location 184 from where the signal is then sent to the PDR 173 via an RF or infrared signal.

Using a standard cable connection system 177, a request packet from a PDR 175 is sent on a wireless transmission signal to a set-top device in a fixed location 186. The transmission signal between the PDR 175 and the fixed location 186 could be either an RF signal in the 2.4 GHz band giving it a range of 500 feet, or through an infra-red transmission with a "line of sight" range. The request packet 140 is then routed through

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the cable 187 to a GRS 176. Data packets 150 are returned from the GRS 176 through the cable 187 to the fixed location 186. The signal is then sent to the PDR 175 via an RF or infrared signal.

5 When a direct broadcast satellite system 179 is employed, a request packet 140 from a PDR 178 is sent on a wireless transmission signal to a set-top device at a fixed location 188. The transmission signal between the PDR 178 and the fixed location 188 could be either an RF signal in the 2.4 GHz band, giving it a range of 500 feet, or through an infra-red transmission with a "line of sight" range. The request packet 140 may then
10 be routed through a low speed path such as a dial-up modem using a telephone system 189, RF or a cellular signal to GRS 176. The data packets 150 are returned from the GRS 176 through a high-speed transmission fiber line 190 to an uplink gateway 191 to a DBS satellite 192 to a receiving dish 193 at the fixed location 188. The signal is then sent to the PDR 178 via an RF or infrared signal.

15 In a further embodiment, a PDR may be made to communicate with a computer which utilizes the Internet to carry a request packet 140 to a GRS and for carrying data packets 150 from the GRS to the requesting PDR through the computer. This arrangement presupposes broadband data communications for the data packets.

20 In another embodiment, the PDR receiver may be a set-top device equipped with an infrared remote control allowing line of sight mobility and with NTSC outputs to a television set for data display. The set-top device may be connected to a communications system such as cable, satellite, xDSL, RF, cellular or telephone.
25 Subscriber requests in the form of PDR packets 140 are transmitted to a GRS. The GRS would then transmit GRS data packets to the set-top PDR over a communications network where at the set-top PDR the data packets are decoded and converted to an audio format to be played through the television set or an amplifier stereo system.

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Many modifications in the above described embodiments of the invention can be carried out without departing from the scope thereof, and therefore the scope of the present invention is intended to be limited only by the appended claims.

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CLAIMS:

1. A system for providing individual subscribers with expressive works independently selected by the subscribers comprising:

5

- a device for each of the subscribers to select an expressive work using an index of a collection of expressive works, the index being located in each of the subscriber devices, and to make a request for the selected expressive work; and

10

- central station means having access to the collection of expressive works to transmit to each subscriber the expressive work requested by the subscriber for substantially immediate performance.

15

2. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 1 wherein the subscriber device comprises:

20

- a transmitter/receiver module for transmitting the request to the central station means and receiving the requested expressive work from the central station;

25

- a control module for maintaining the index and for interfacing with the subscriber to select the expressive work; and

- player circuit for receiving and performing the requested expressive work.

30

3. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 2 wherein the central station means comprises:

- a plurality of computer servers having digital storage for hosting the collection of expressive works as a digital data bank; and
- a supervisory server for receiving requests from the subscriber devices and allocating the requests to the servers.

4. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 3 wherein the plurality of servers are coupled to the supervisory server through a broadband transmission medium.

5. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 1 wherein the subscriber devices are coupled to the central station means through a communications network.

6. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 5 wherein the communications network is a constellation of low earth orbit satellites.

7. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 2 wherein the subscriber device includes a housing with display means and button sets for interfacing with the subscriber.

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8. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 3 wherein the supervisory server includes:

- 5 - means for appending further expressive works to the digital data base; and
- means for generating and storing index updates for the appended further expressive works and for transmitting the index updates to the subscriber
- 10 devices.

9. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 5 wherein the expressive works are audio works.

10. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 9 wherein the subscriber device includes audio means to play the requested audio work.

11. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 9 wherein the types of audio works comprise at least one of vocal music, instrumental music, educational works, literary works.

12. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 5 wherein the index is a categorized index.

13. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 2 wherein the control module includes memory means for storing one or more lists of subscriber selections.

14. A system for providing individual subscribers with expressive works independently selected by the subscribers comprising:

- a device for each of the subscribers to select an expressive work using an index of a collection of expressive works, the index being located in each of the devices, and to make a request for the selected expressive work; and
- one or more regional station means having access to the collection of expressive works to transmit to each subscriber associated with a regional station the expressive work requested by the subscriber for substantially immediate performance.

15. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 14 wherein the subscriber device comprises:

- a transmitter/receiver module for transmitting the request to the central station means and for receiving the requested expressive work from a respective regional station means;
- a control module for maintaining the index and for interfacing with the subscriber to select the expressive work; and
- player circuit for receiving and performing the requested expressive work.

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16. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 15 wherein each regional station means comprises:

- a plurality of computer servers having digital storage for hosting the collection of expressive works as a digital data bank; and
- a supervisory server for receiving requests from the subscriber devices and allocating the requests to the servers.

17. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 16 wherein the plurality of servers are coupled to the supervisory server through a broadband transmission medium.

18. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 16 wherein the supervisory servers are linked together through a broadband transmission medium.

19. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 14 wherein the subscriber devices are coupled to the associated regional station means through a communications network.

20. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the communications network includes a cellular network.

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21. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the communications network includes an rf network.
- 5 22. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the communications network includes an xDSL network.
- 10 23. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the communications network includes a standard cable system.
- 15 24. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the communications network includes a direct broadcast satellite system.
- 20 25. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the communications network includes one or more of the followings systems: a constellation of low orbiting satellites, a cellular network, an rf network, an xDSL network, a standard cable system, a direct broadcast satellite system.
- 25 26. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the communications network includes a first low transmission rate network for transmitting subscriber device requests to a regional station means and a second high transmission rate network for transmitting the expressive work from the regional station means to the subscriber device.

30

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27. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 15 wherein the subscriber device includes a housing with display means and button sets for interfacing with the subscriber.

28. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 16 wherein the supervisory server includes:

- means for appending further expressive works to the digital data base; and
- means for generating and storing index updates for the appended further expressive works and for transmitting the index updates to the subscriber devices.

29. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the expressive works are audio works.

30. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 27 wherein the subscriber device includes audio means to play the requested audio work.

31. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the types of audio works comprise at least one of vocal music, instrumental music, educational works, literary works.

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32. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 19 wherein the index is a categorized index.

5 33. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 15 wherein the control module includes memory means for storing one or more lists of subscriber selections.

10 34. A system for providing individual subscribers with expressive works independently selected by the subscribers as claimed in claim 15 wherein the control module includes means to delete, modify or save the lists of subscriber selections.

15 35. A method for providing individual subscribers with independently selected expressive works comprising:

- selecting an expressive work from a local index of a collection of expressive works;
- 20 - formulating a request for the selected expressive work;
- transmitting the request to a central location having access to the collection of expressive works; and
- 25 - transmitting the selected expressive work to the requesting subscriber for substantially immediate performance.

30 36. A method for providing individual subscribers with independently selected expressive works as claimed in claim 35 wherein the collection is stored in a digital data base.

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37. A method for providing individual subscribers with independently selected expressive works as claimed in claim 35 wherein the index is a categorized index.

38. A method for providing individual subscribers with independently selected expressive works as claimed in claim 36 and further includes:

- periodically adding further expressive works to the digital data base;
- creating an index update of the expressive works added to the digital data base; and
- transmitting the index update to each of the subscriber locations.

39. A method for providing individual subscribers with independently selected expressive works as claimed in claim 35 in which the expressive works are audio works.

40. A method for providing individual subscribers with independently selected expressive works as claimed in claim 39 in which the audio works include vocal and instrumental music, educational and literary works.

41. A method for providing individual subscribers with independently selected expressive works comprising:

- storing a collection of expressive works in a central location;
- creating an index of the collection of expressive works;
- storing the index at the central location and at each local subscriber location;

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- at the subscriber locations, selecting one or more expressive works from the local index at any time as determined by the individual subscribers;
- formulating requests for an individually selected work at the individual subscriber locations;
- transmitting the requests from the individual subscriber locations to the central location;
- at the central location, accessing the selected expressive works requested by the individual subscriber locations;
- transmitting the respective requested expressive works to the respective individual requesting subscriber locations;
- receiving the respective requested expressive works at the individual requesting subscriber locations; and
- performing the transmitted works at the individual subscriber locations.
42. A method for providing individual subscribers with independently selected expressive works as claimed in claim 41 and further comprising:
- periodically adding further expressive works to the collection of expressive works;
- creating an index update of the expressive works added to the collection of expressive works; and
- transmitting the index update to each of the subscriber locations.

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43. A method for providing individual subscribers with independently selected expressive works as claimed in claim 42 wherein the index is a categorized index.

44. A method for providing individual subscribers with independently selected expressive works as claimed in claim 41 wherein the performing step includes:

- buffering the transmitted expressive work; and
- selecting a point in the buffered expressive work to commence performance.

45. A method for providing individual subscribers with independently selected expressive works as claimed in claim 44 which further includes altering the point in the buffered expressive work where the work is being performed.

46. A method for providing individual subscribers with independently selected expressive works as claimed in claim 41 wherein the selecting step includes:

- at the subscriber locations, selecting a number of expressive works using the local index at any time as determined by the individual subscribers;
- placing at least one selected expressive works on one or more selection lists; and

wherein the request formulating step includes formulating a request for one of the selected works from one of the selection lists.

47. A method for providing individual subscribers with independently selected expressive works as claimed in claim 41 wherein the collection of expressive works are in a digital data bank.

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48. A method for providing individual subscribers with independently selected expressive works as claimed in claim 41 wherein the expressive works are audio works.

5 49. A method for providing individual subscribers with independently selected expressive works as claimed in claim 41 wherein the audio works types include vocal music, instrumental music, educational works, literary works.

10 50. A method for providing individual subscribers with independently selected expressive works as claimed in claim 41 wherein the performing step includes starting, pausing or stopping the requested expressive work.

15 51. A method for providing individual subscribers with independently selected expressive works comprising:

i. selecting one or more expressive works from a local index of a collection of expressive works;

20 ii. placing the selected expressive works on a selection list;

iii. formulating a request for one of the selected expressive works on the selective list;

25 iv. transmitting the request to a central location having access to the collection of expressive works;

v. transmitting the selected expressive work to the requesting subscriber from the central location for substantially immediate performance; and

30 vi. repeating the steps iii, iv and v in sequence for each of the selected expressive works on the selection list.

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52. A method for providing individual subscribers with independently selected expressive works as claimed in claim 50 wherein steps iii, iv, v and vi are repeated at least once.
- 5 53. A method for providing individual subscribers with independently selected expressive works as claimed in claim 50 wherein the selection steps i is based on a subscriber defined criteria.

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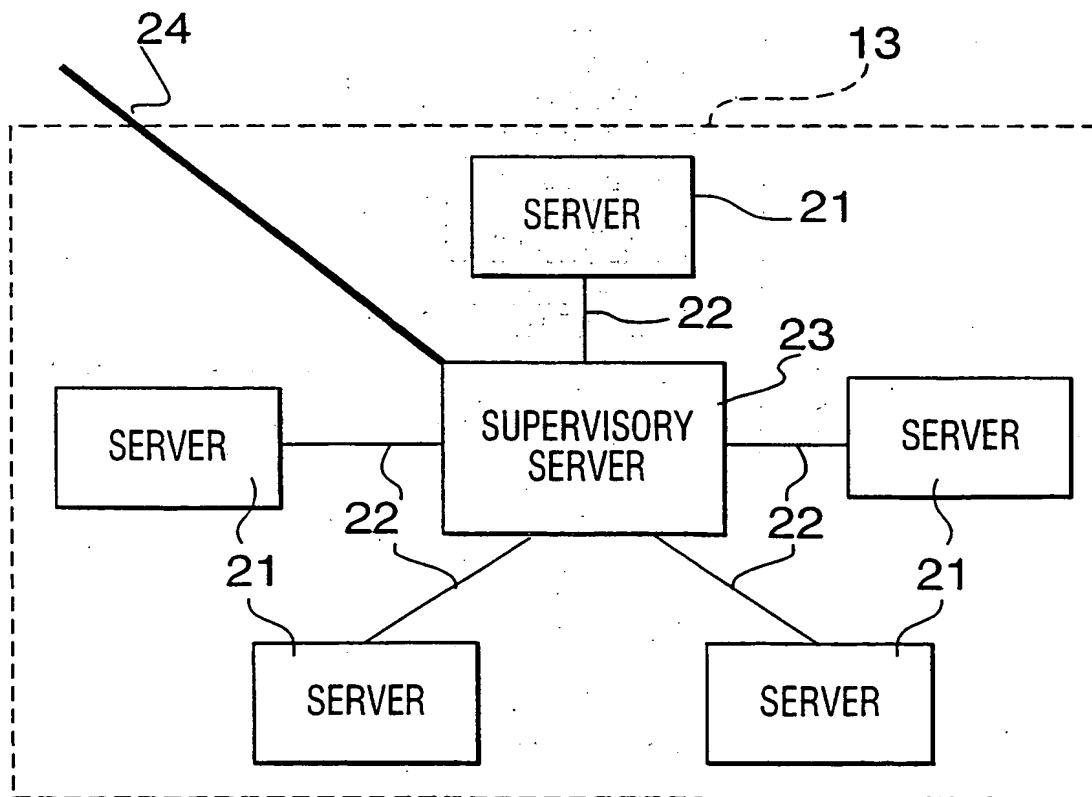
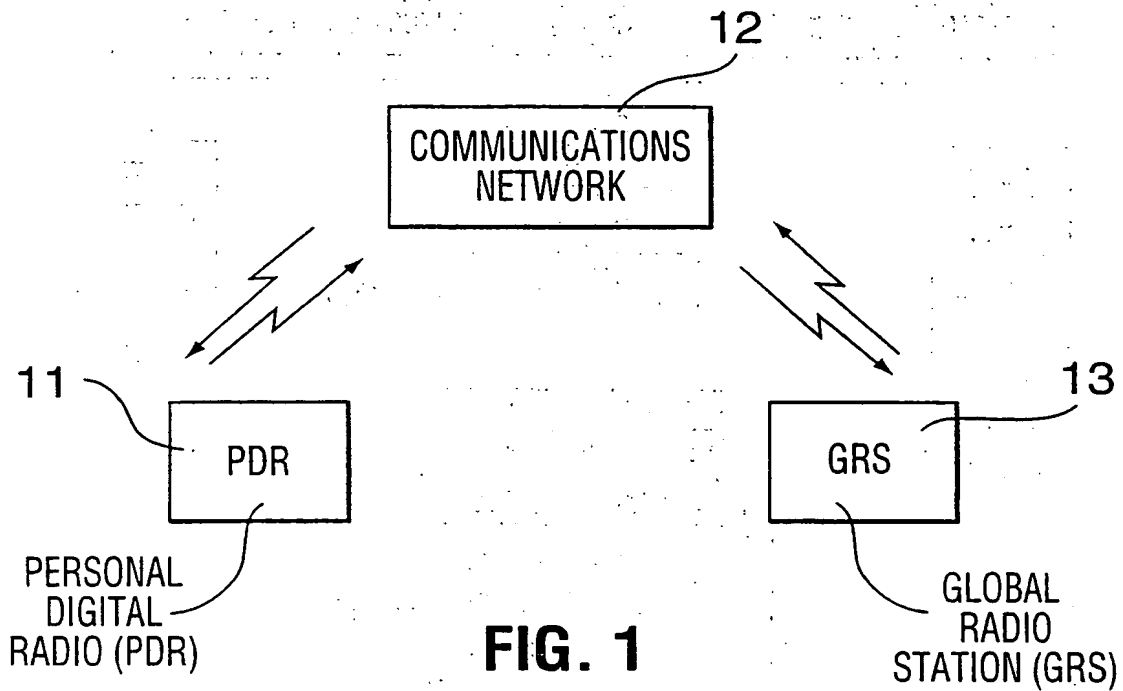
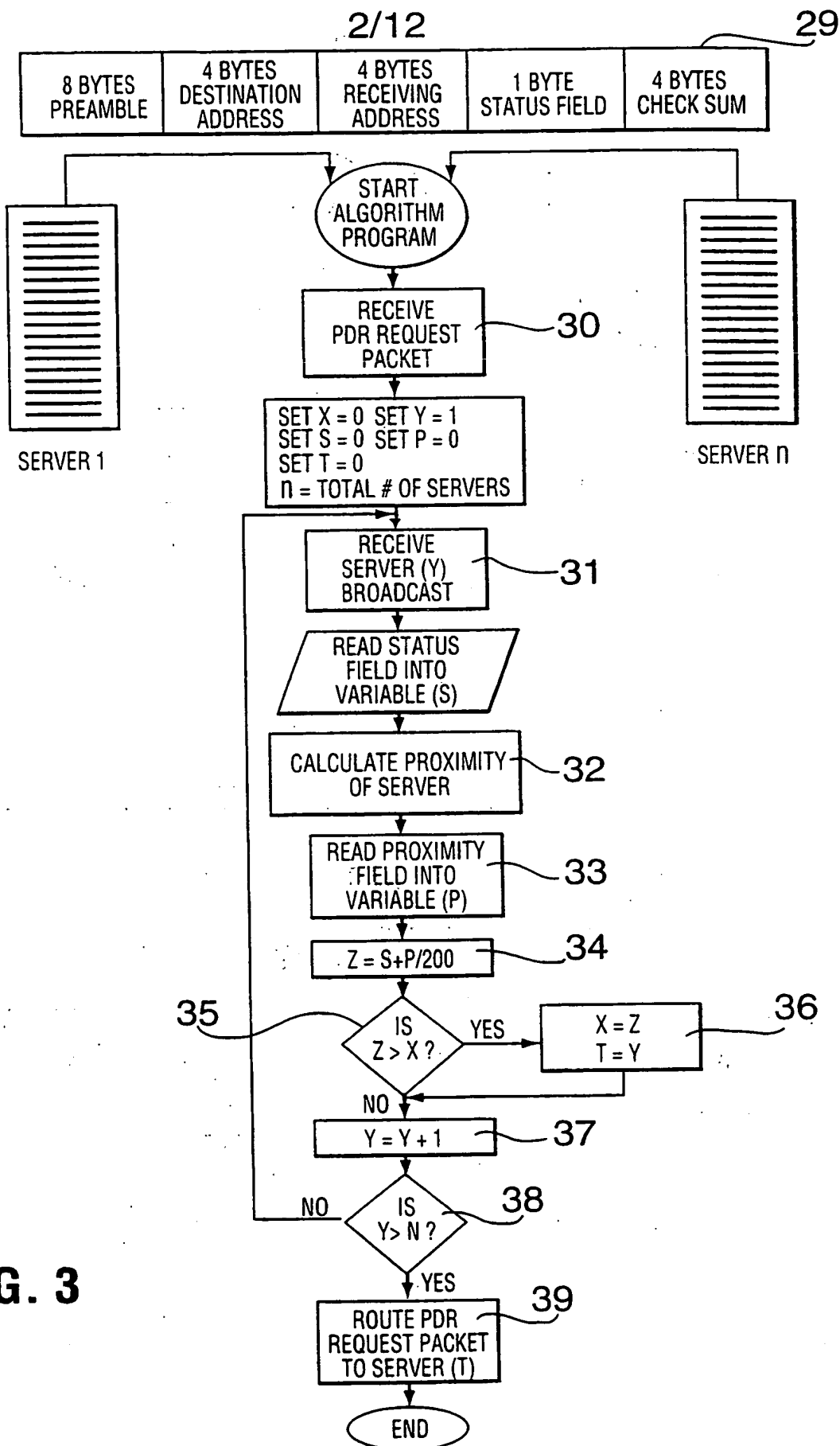


FIG. 2



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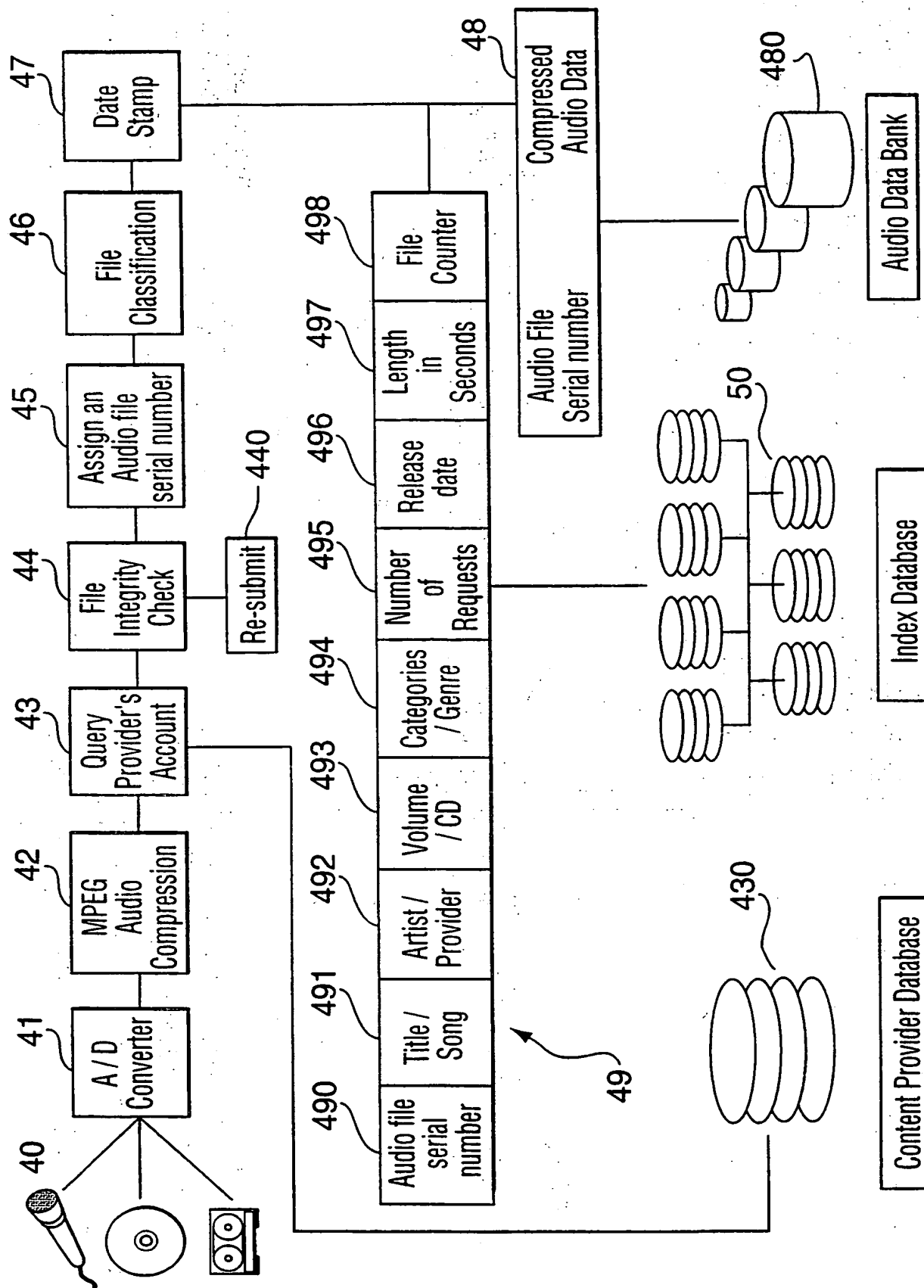


FIG. 4

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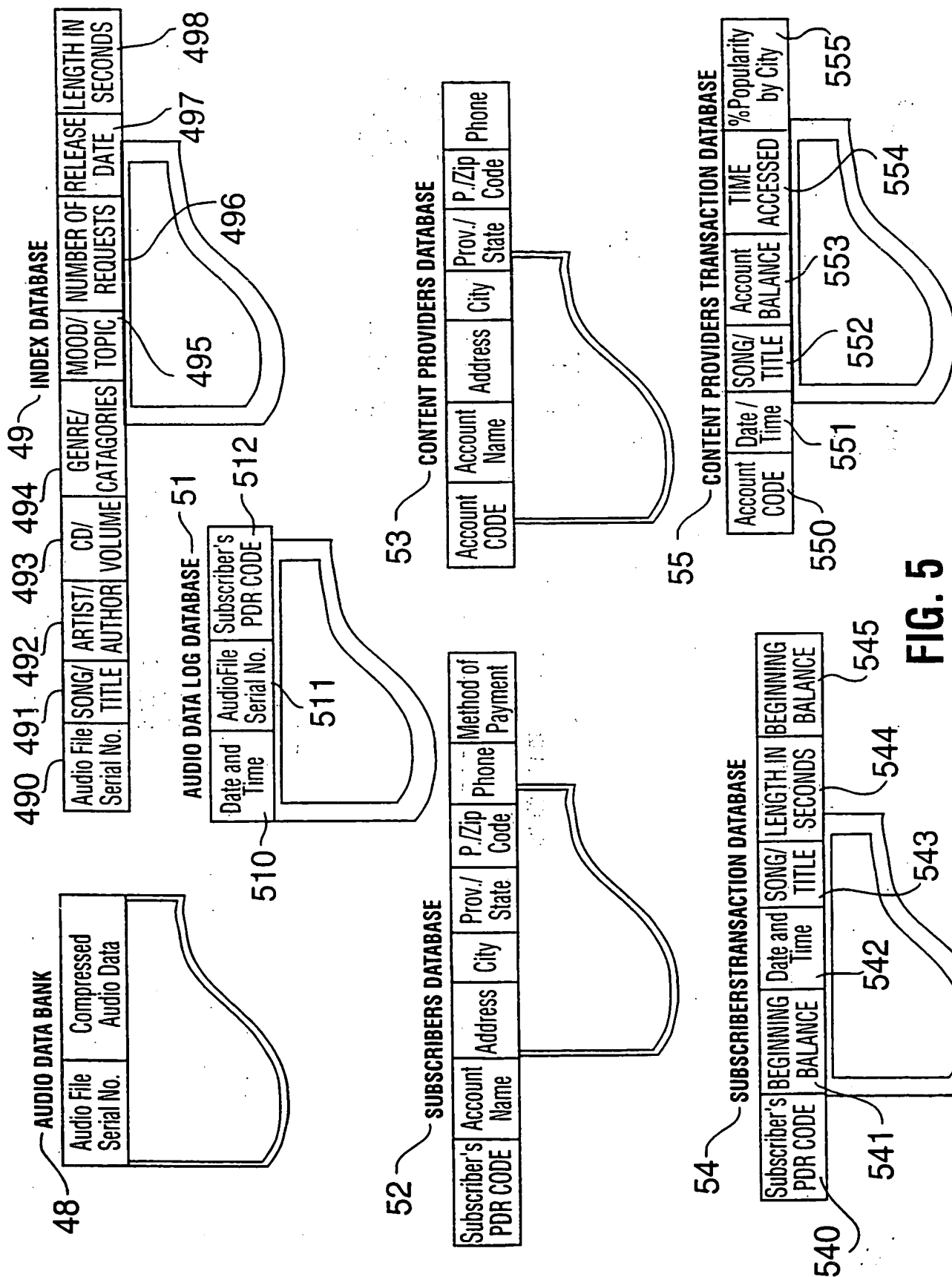


FIG. 5

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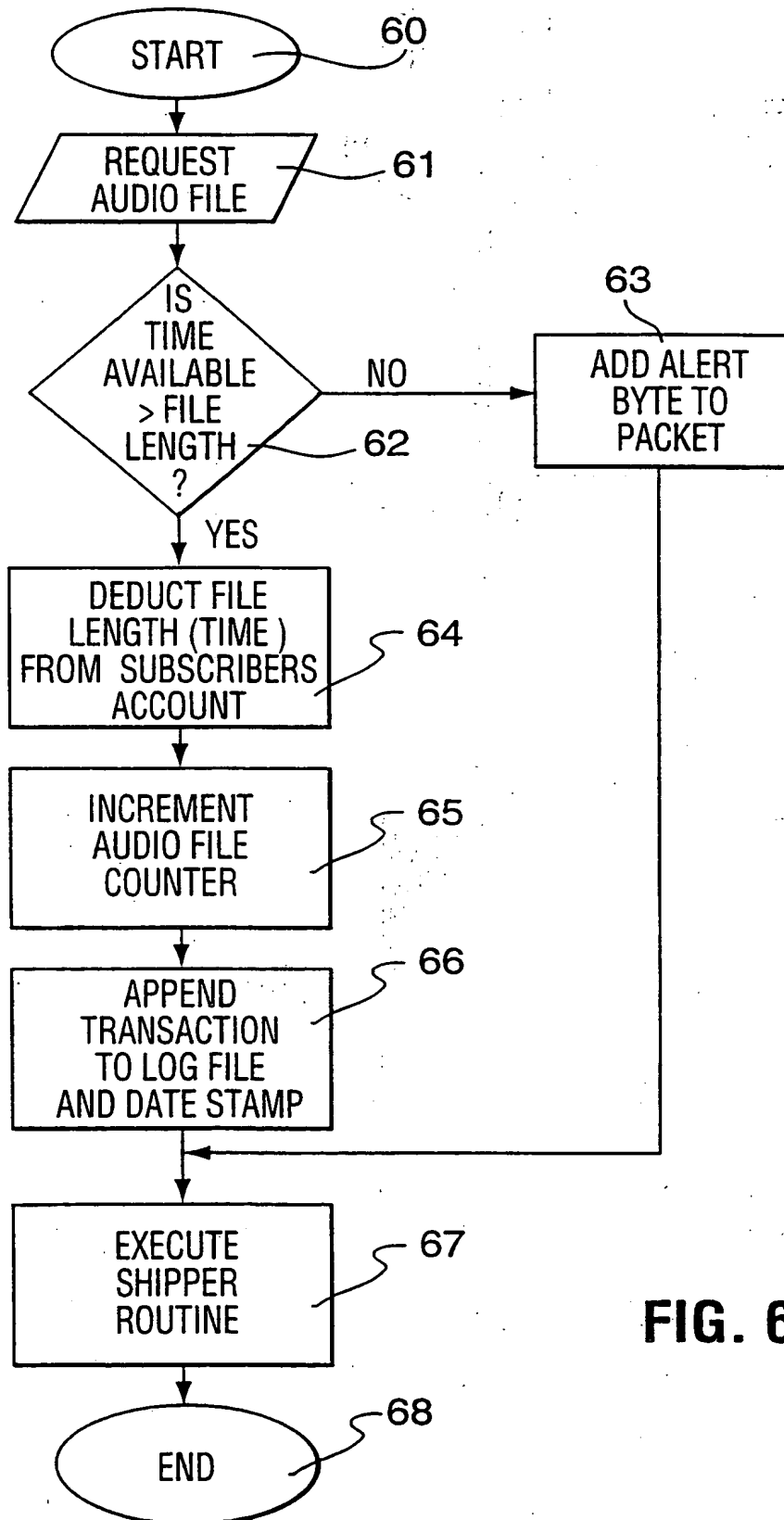


FIG. 6

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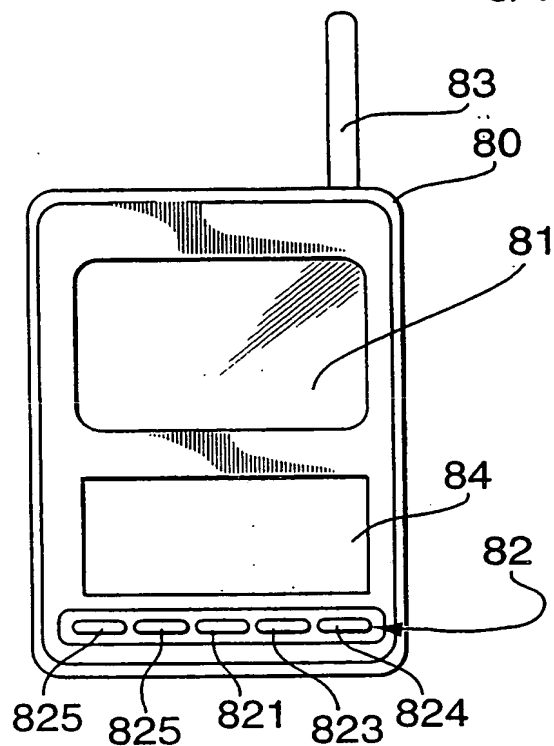


FIG. 8

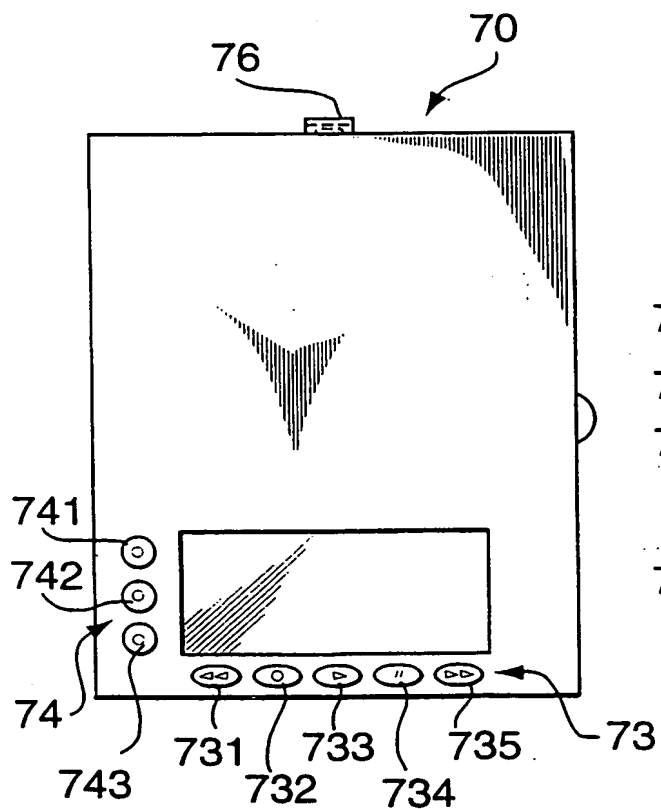


FIG. 7a

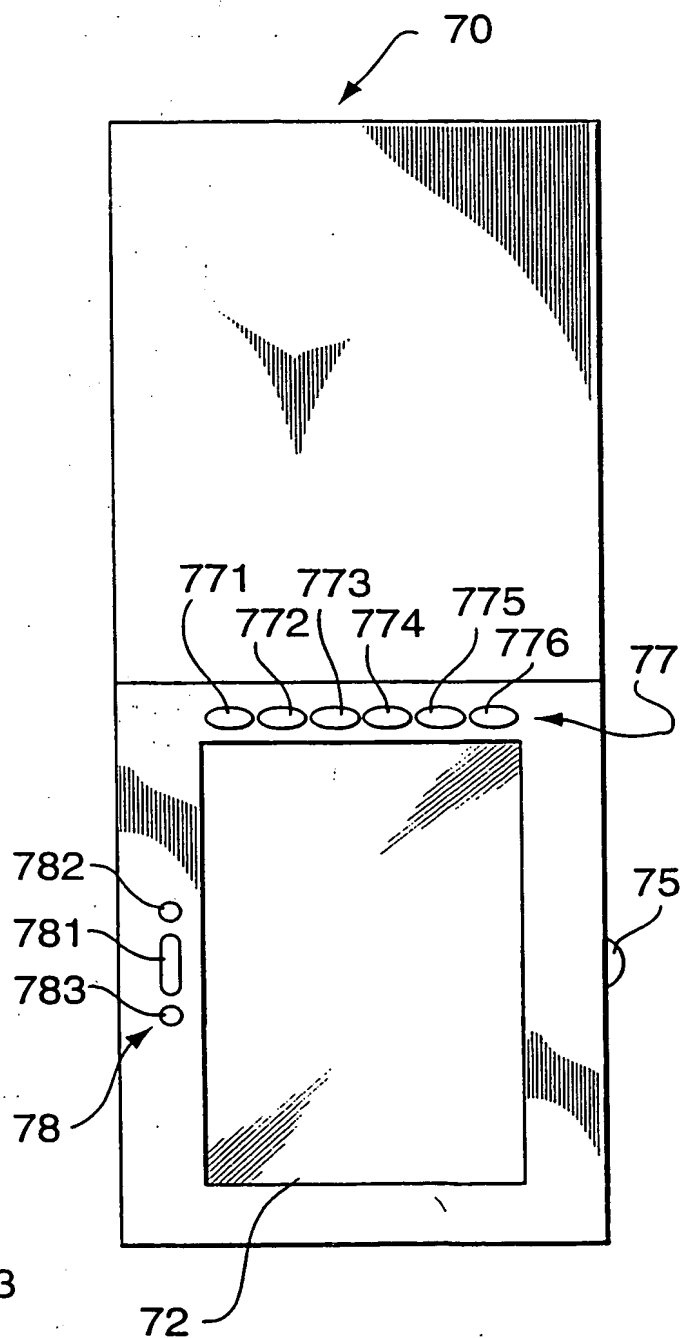


FIG. 7b

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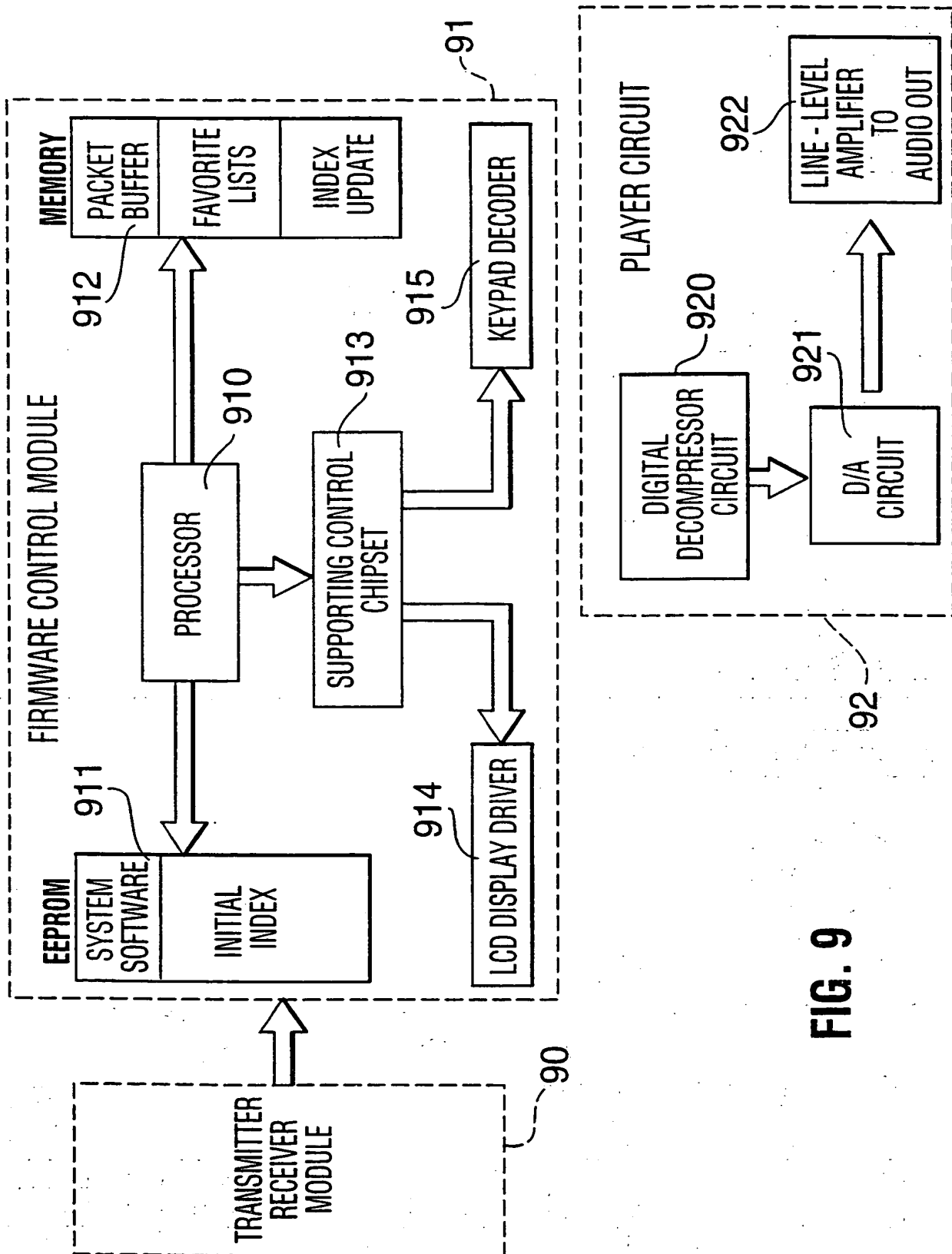
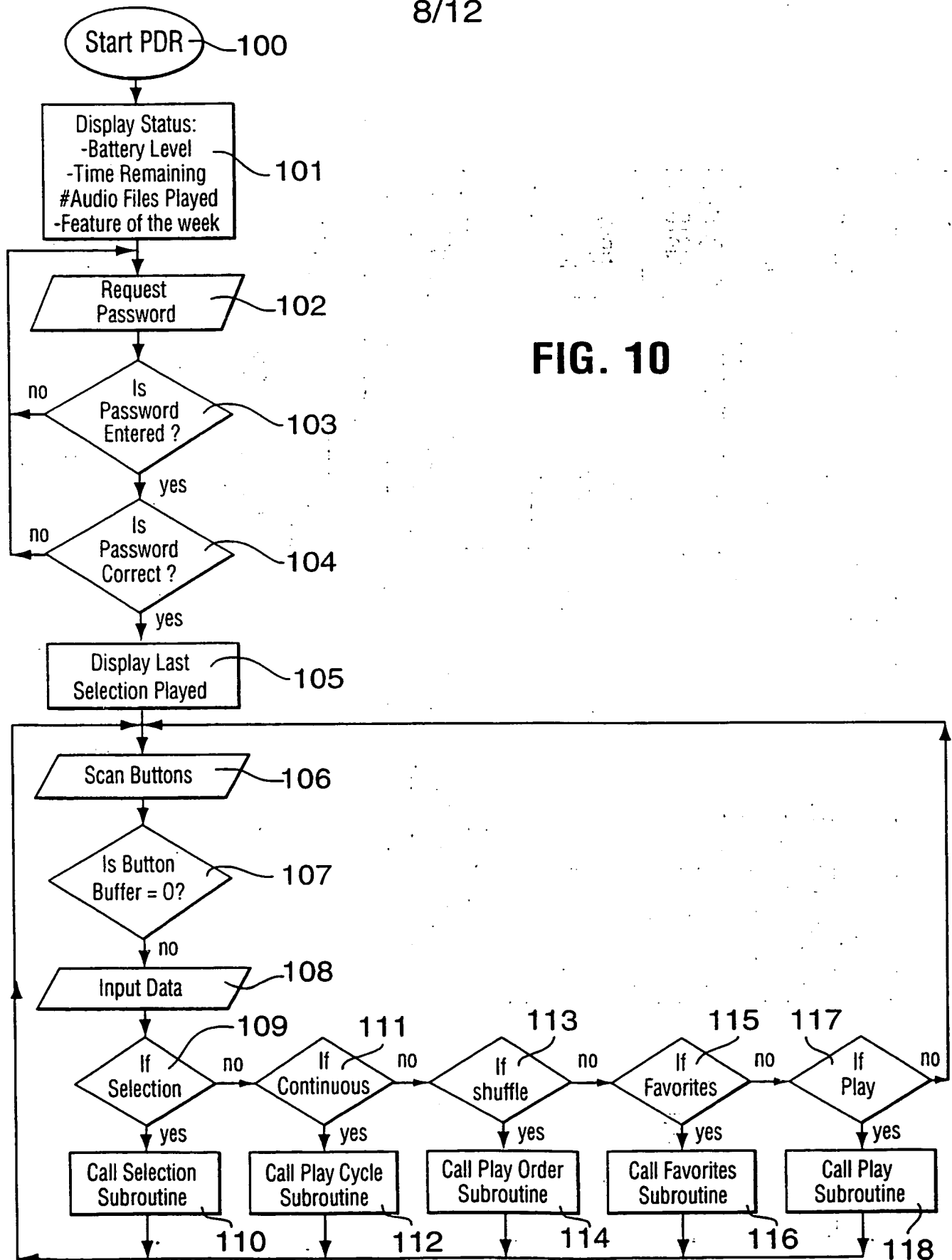


FIG. 9

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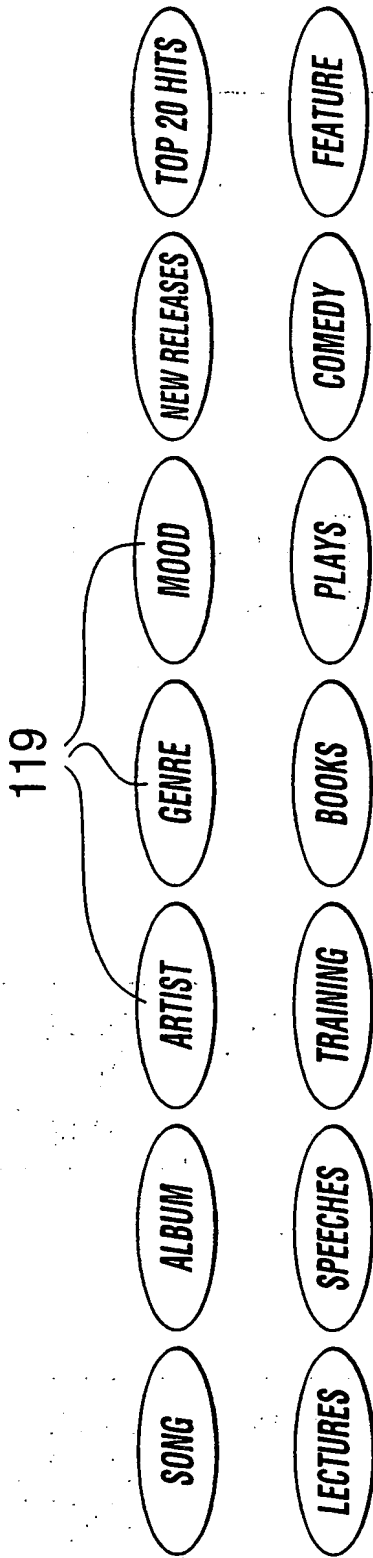


FIG. 11

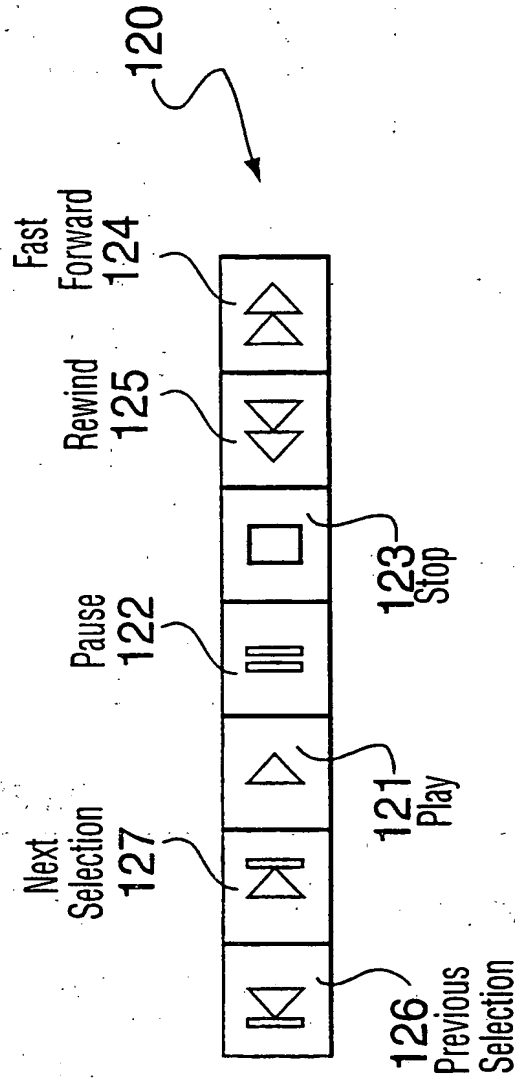
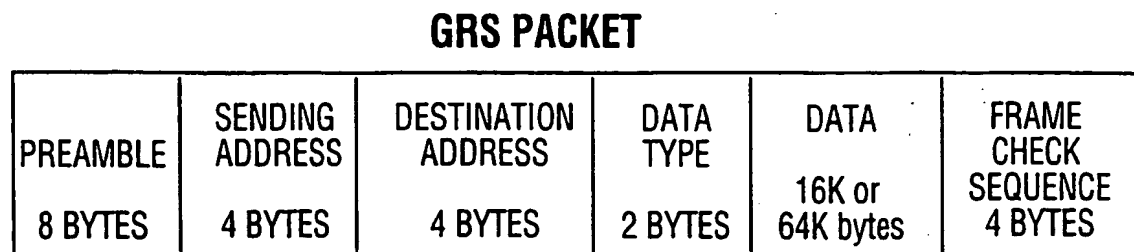
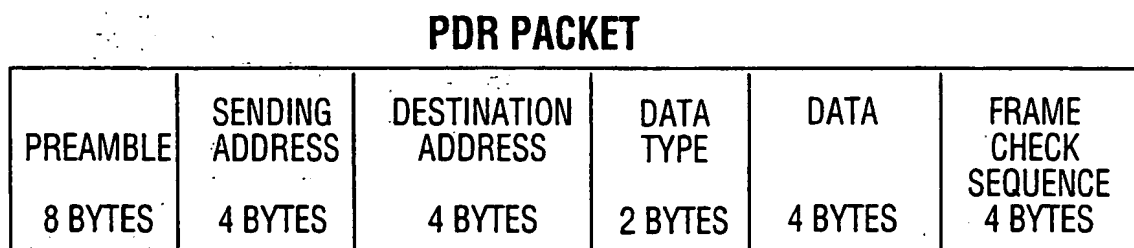
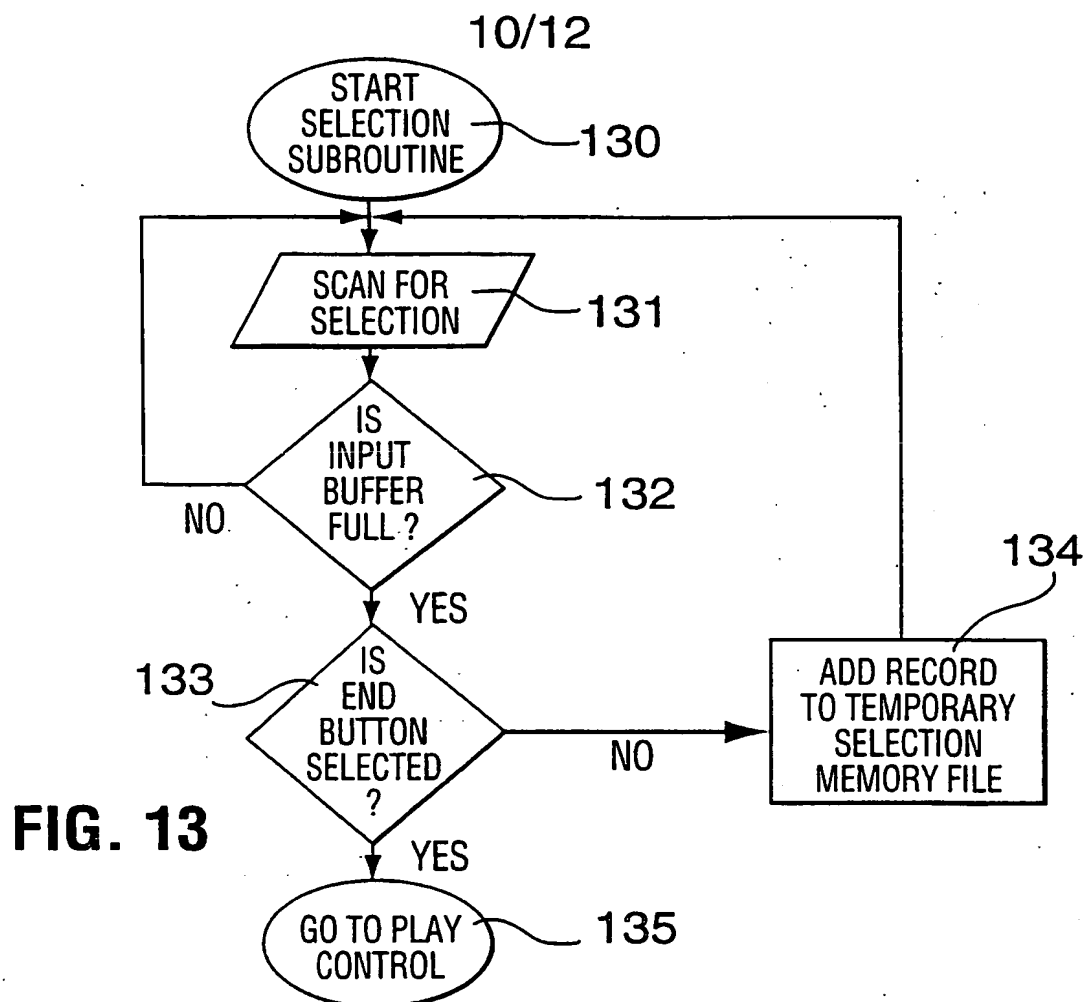


FIG. 12



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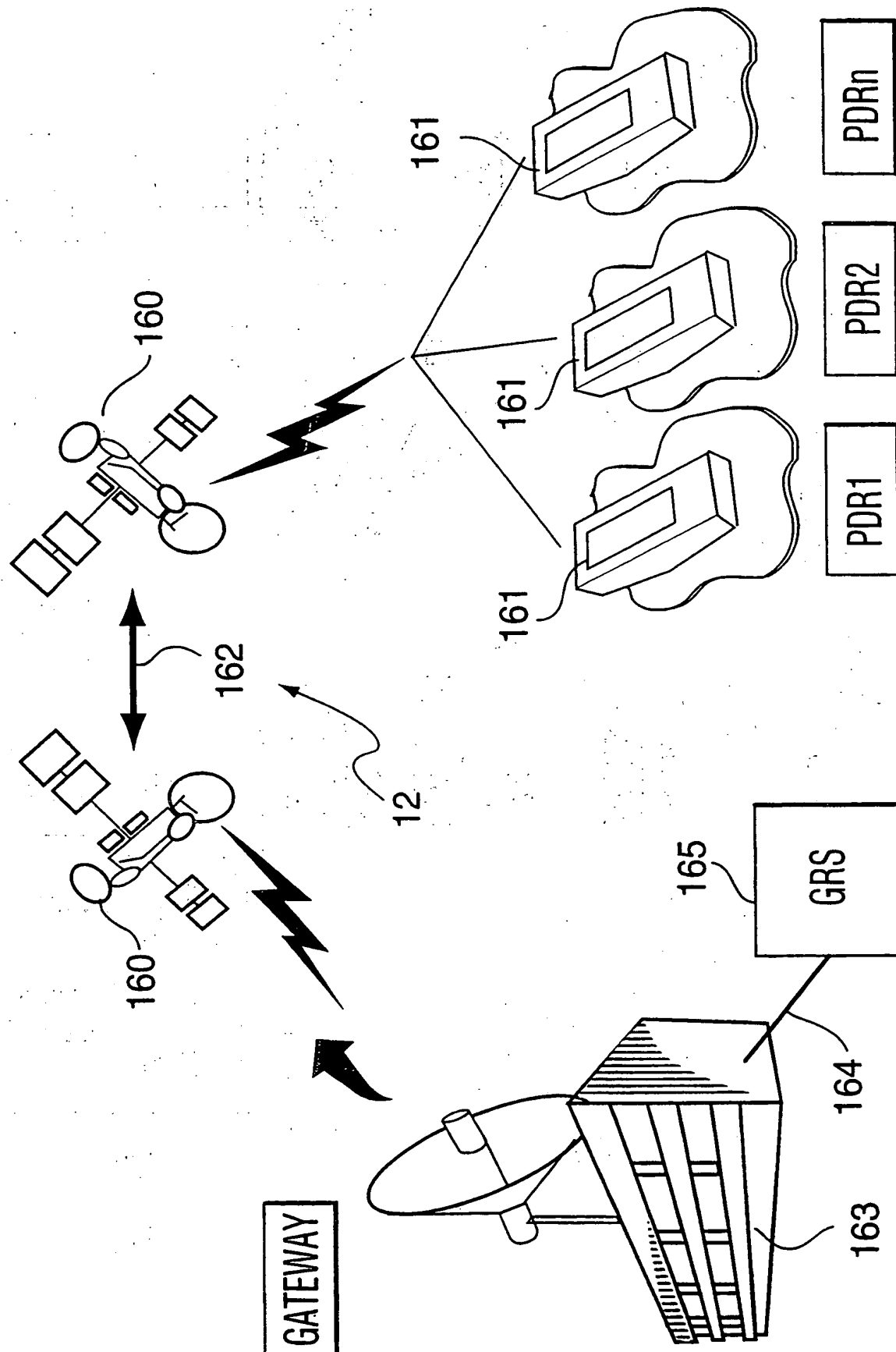


FIG. 16

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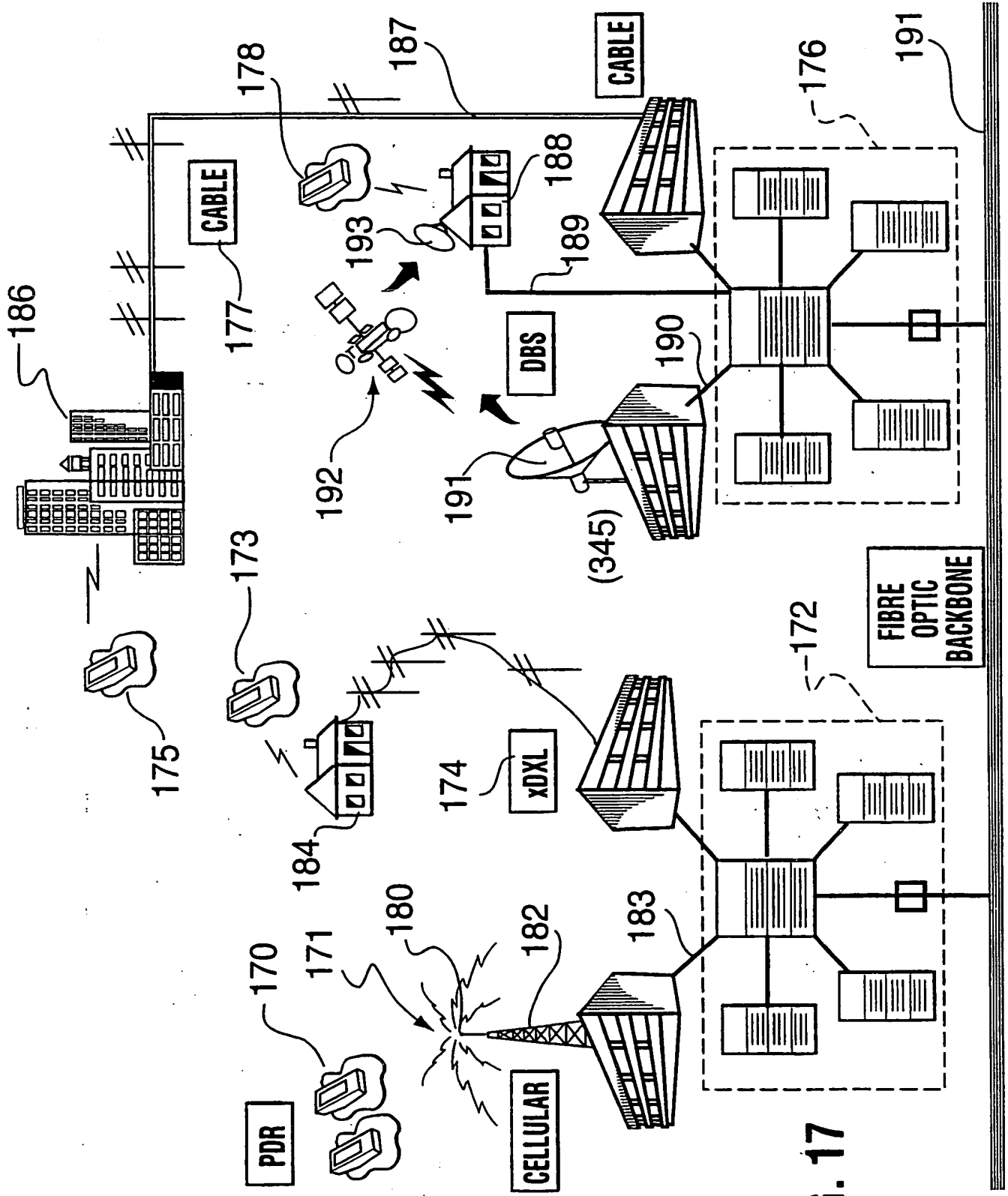


FIG. 17

INTERNATIONAL SEARCH REPORT

International Application No

PCT/CA 99/00568

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04H1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 93 09631 A (FINISAR CORP) 13 May 1993 (1993-05-13) page 1, line 1 -page 5, line 7; claim 1; figure 1	1, 14, 35, 41, 51
A	US 5 734 119 A (FRANCE GORDON SCOTT ET AL) 31 March 1998 (1998-03-31) column 1, line 1 -column 8, line 25; claim 1; figure 1	1, 14, 35, 41, 51
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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